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Entrepreneurial Ecosystem for Technology Start-ups in Nairobi: Empirical analysis of Twitter networks of Start-ups and Support organizations

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Abstract

The literature on 'entrepreneurial ecosystem' places emphasis on understanding the surrounding business environment for entrepreneurial activities of individual actors in a system, typically defined at a city or regional level. This line of literature is still relatively new in development with potential to provide a useful framework for entrepreneurship policy. In this paper, we address some of the limitations of current research on 'entrepreneurial ecosystem' in order to advance our understanding of the construct. First of all, we draw our attention to connection and interaction between the elements of the ecosystem, which has received relatively little attention in previous empirical studies. Secondly, we address one important shortcoming of the previous studies – focus on the ecosystems in developed economies – in order to shed light on some peculiarities of development of entrepreneurial ecosystem in developing economies. Our current study attends to these issues with a relatively new methodology. We analyse networks of Twitter mentions of technology ventures and support organizations to study the interaction among the two types of central actors in the entrepreneurial ecosystem in Nairobi, Kenya. We argue that, for developing economies, which lack certain resources and formal institutions, support organizations of various origins can serve as a critical driving force in creating supportive entrepreneurial ecosystems. With an exploratory empirical analysis, we present interaction dynamics among start-ups and support organizations and identify two distinctive communities in the ecosystem based on the technological focus, the types of support organizations and interaction pattern in the network.

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1 Introduction

Since entrepreneurship as an important driving force for economic growth has been emphasised by Schumpeter (1934), dedicated research on entrepreneurship has served as foundation for formulating policies with the aim of encouraging entrepreneurship. During the last two decades, the rise of Silicon Valley has fuelled special interest of policy makers in creating favourable environment for venture creation with its extraordinary achievement in fostering start-ups based on new emerging ICT technologies. The success story of Silicon Valley became an eye opener for many policy makers in developed economies with stagnating growth and eventually used as benchmark for facilitating new venture creation in many cities and regions all over the world (Bresnahan et al., 2001).

Especially, the increasing focus on technology-based entrepreneurship coincided with the recent empirical findings showing that not all new businesses contribute to economic growth (Wong et al., 2005; Stam et al., 2009). Studies in entrepreneurship research started to distinguish necessity-driven entrepreneurship and opportunity-driven entrepreneurship in assessing their economic impact and found that only opportunity entrepreneurship contributes positively to economic development (Acs and Varga, 2005). In line with this, traditional view on entrepreneurship as 'self-employment' and 'small businesses' has lost its value in drawing implication for policy, while more emphasis has been placed on 'high-growth firms' and 'ambitious entrepreneurs' (Stam et al., 2012). As technology-based ventures are mainly founded by detecting market opportunities originating from new technologies, they are also likely to be associated with high growth potential or high ambition level of entrepreneurs.

The emphasis on technology-based entrepreneurship has also been detected in the context of developing economies. The emergence of technology entrepreneurship in Africa, mainly based on new ICT technologies, is gaining attention with its potential to achieve leapfrogging and economic catch-up (Osiakwan, 2017). The new technologies with short life cycle allow entrepreneurs to quickly acquire emerging technological competences to compete with global players, which deviates from traditional industrial development path preceded by developed countries (Lee, 2013). Not only do the new ventures show the potential to achieve economic growth, but a fair number of them also address basic social issues in the society based on new technologies (Hain and Jurowetski, 2015). For these economies, supporting technology

entrepreneurship could be an efficient way to achieve both 'social' and 'economic' development simultanously.

How to effectively support entrepreneurship has been major consideration of many policy makers and researchers. While earlier focus has been placed on entrepreneurs as individuals with special characters and behaviours, there has also been increasing attention towards understanding contextual factors for entrepreneurial activities with a holistic view (Audretsch and Belitski, 2016). The recently emerged concept of entrepreneurial ecosystem seems to serve this need as it balances focus on entrepreneurs as individual actors and the system-level conditions as contextual factors, with the recognition that individual entrepreneurial actions are largely influenced by the local business environment (Isenberg, 2011; Mason and Brown, 2014; Stam, 2015). Similar to the systemic approach to innovation as in the innovation system framework (Lundvall, 1992; Freeman, 1995), this framework suggests that entrepreneurship happens in a system that consists of various actors involved in entrepreneurial activities and their interaction within local environment, which is typically demarcated with the boundaries of cities and regions.

Despite its advantage to provide holistic assessment of ecosystem for policy makers, this approach has rarely been applied in the context of developing economies. We argue that the ecosystem framework can be a useful tool in pointing out weak and strong elements in the local business environment, which will then guide the developing economies in leveraging relatively strong resources for facilitation of entrepreneurial activities. In this study, we apply the framework to identify ecosystem around technology start-ups in Nairobi, Kenya, one of the leading entrepreneurial hubs in African continent. More specifically, we analyse networks of Twitter mentions between technology start-ups and support organizations in order to analyse entrepreneurial communities that constitute an important part of Kenyan entrepreneurial ecosystem. We propose that, in resource-scarce developing economies with weak institution and knowledge base, entrepreneurial communities serve as a major driving force in nurturing entrepreneurship.

This study contributes to the literature in the following ways. First of all, we draw our attention to connection and interaction between the elements of the ecosystem, which has received relatively little attention in previous empirical studies (Motoyama and Watkins, 2014). Secondly, we address one important shortcoming of the previous studies – focus on the ecosystems in developed economies – in order to draw implications on some peculiarities of development of

entrepreneurial ecosystem in developing economies. Thirdly, we incorporate historical perspective in studying the emergence of communities in certain locations and present evidence for heterogeneous communities within an ecosystem. Last but not least, we utilize new data and methodology that allows us to analyse elements of the system that are otherwise hard and time-consuming to gather data on.

The structure of the paper is as follows. The next section of the paper discusses theoretical background for entrepreneurial ecosystem. Then, the empirical context of Nairobi and the methodology will be explained in the following sections. We proceed to presentation of the results from the empirical analysis on networks, which is followed by discussion and conclusion of the paper.

2 Theoretical background

2.1 Entrepreneurial ecosystem

Recent trend in entrepreneurship research shows that the focus has shifted from entrepreneurs as individuals with certain characteristics and behaviours towards a holistic understanding of how entrepreneurial actions are taking place in certain territories (Feld, 2012; Acs et al., 2014; Audretsch and Belitski, 2016). Considering that entrepreneurship plays an important role in economic growth (Audretsch and Lehmann, 2005), understanding the systemic nature of entrepreneurial success seems like a due objective of research in this domain. The increasing attention to the local context in which individual entrepreneurs pursue their opportunities contributes to establishing a more balanced view in recognizing that both 'individual entrepreneurial action' and 'contextual factors' matter for entrepreneurship (Audretsch and Belitski, 2016).

One of the early conceptualization of systemic nature of entrepreneurship was suggested by Spilling (1996) who defined an entrepreneurial system as a system consisting of "a complexity and diversity of actors, roles, and environmental factors that interact to determine the entrepreneurial performance of a region or locality (p.91)." The systemic thinking recognizes the importance of various actors/factors that exist within a system and their interaction in creating the environment for venture creation. Similar understanding of entrepreneurial system is also found in

the work of Van de Ven (1993) and Neck et al. (2004) who asserted the importance of interaction of various elements in creating entrepreneurial infrastructure.

During the last decade or so, the concept of entrepreneurial ecosystem has emerged as a framework to illustrate the systemic nature of entrepreneurial activities anchored within certain geographical boundary (Isenberg, 2011; Napier and Hansen, 2011; Stam, 2015; Spigel, 2017). While there is no one universal definition, the general understanding of the concept seems to be "a set of interdependent actors and factors coordinated in such a way that they enable productive entrepreneurship (Stam, 2015, p.1765)." The actors involved in the ecosystem could be, for example, 1) potential and existing entrepreneurial actors, 2) entrepreneurial organizations such as firms, venture capitalists, business angels and banks, and 3) institutions like universities, public sector agencies, and financial bodies (Mason and Brown, 2014). The other interconnected factors may include social, political, economic and cultural elements within a certain regional boundary as Spigel (2017) specifies. In other words, the ecosystem can be understood as a community and network of various actors and the system-level institutional and socioeconomic contextual factors (Audretsch and Belitski, 2016).

In most studies within this literature[2], entrepreneurship is conceptualised as new venture creation by 'individual' entrepreneurs (Isenberg, 2011; Audretsch and Belitski, 2016; Spigel, 2017). Central actors in focus in the ecosystem, therefore, are most often start-ups and entrepreneurs behind the start-ups. Stam (2015) pointed out that there is a tendency to focus on "high-growth start-ups" rather than more traditional definition of entrepreneurship as "self-employment" or "small businesses" in previous studies on the ecosystems with the argument that it is rather this type of entrepreneurship that contributes to innovation, productivity and employment (Napier and Hansen, 2011; Mason and Brown, 2014).

There have been attempts to identify various elements and pillars of the entrepreneurial ecosystem in developing the holistic view of the system. Isenberg (2011) pinpointed 12 elements (further consolidated in 6 domains) that need to be present in order for the system to be self-sustainable: policy (government initiatives and leadership), markets (early customers and networks), finance (capital), human capital (Labor and educational institutions), culture (success stories and societal norms), and supports (infrastructure, support professions, and non-government

[2] Stam (2014) include activities by 'entrepreneurial' employees in established firms as a form of entrepreneurship in the analysis of Dutch entrepreneurial ecosystem.

institutions). Similarly, World Economic Forum (2013) lists 8 pillars (accessible markets, human capital/workforce, funding and finance, support systems, government and regulatory system, Education and training, universities, and cultural support) that overlaps with the elements identified by Isenberg (2011).

The initial identification of elements and pillars led to more structured models of entrepreneurial ecosystem following the recognition that there is lack of relational configuration between the elements. Stam (2015) suggested a model with four ontological layers connected with causal relations. Each of the four layers consist of framework conditions (formal institution, culture, physical infrastructure and demand), system conditions (networks, leadership, finance, talent, knowledge, and support services/ intermediaries), outputs (entrepreneurial activity), and outcomes (aggregate value creation). Elements in the framework conditions represents social and physical conditions for human interaction, which forms the fundamental causes leading to entrepreneurial activity, but what determines the success of the entrepreneurial activity is how well elements in the system conditions work together. These elements together induce entrepreneurial activities as outputs that further lead to aggregate value creation in the society as final outcome. In this model, entrepreneurial activities can be manifested in different forms such as innovative start-ups, high-growth start-ups, and entrepreneurial employees, but what is considered most critical is that these activities create aggregate welfare increases in the end.

Spigel (2017) categorized some elements of ecosystem into three groups and illustrated how they are related to each other. The first group represents cultural attributes including cultural attitudes towards entrepreneurship and success stories as histories of entrepreneurship. The second group of elements, social attributes, are basically resources from social networks existing in the system and include network themselves, investment capital, mentor/dealmakers, and worker talents. Lastly, material attributes are tangible elements such as universities, policy and governance, physical infrastructure, support services, and open markets. These three categories of attributes influence and reinforce each other in a system and thereby work in tandem in order to support entrepreneurship. For example, cultural beliefs and values facilitate formation of social network of various actors and interaction among them. The dense connection between the actors, on the other hand, reinforces and strengthens creation of common values and norms in the system. Furthermore, social attributes like active communities of entrepreneurs and mentors could support development of material attributes like policies and support services. Spigel (2017) asserts that

some elements can be missing even in a thriving ecosystem and the attributes should merely be understood as the factors that create supportive environment for entrepreneurship.

Although the previous literature generally defines the ecosystems at a regional (sub-national) level, it is still not completely clear at what level entrepreneurial ecosystems can be or should be applied in terms of their geographical boundaries (Stam, 2015). The previous empirical studies on the ecosystem show that the concept has been applied in various local contexts such as cities, counties, regions, and nations (Neck et al., 2004; Napier and Hansen, 2011; World Economic Forum, 2013; Spigel, 2015; Audretsch and Belitski, 2016). As Stam (2015) pointed out, some elements like human labor pool and social networks can be better defined at a regional level, while other elements like government policy and regulations can be applied in a broader national context. What could be more important in determining the geographical scope can be interaction among the actors through which the entrepreneurial activities are taking place and resources needed for the activities are sourced. In certain cases, one may also detect strong connections beyond regional and national borders through the activities of global entrepreneurs, investors or support organizations (Malecki, 2011).

2.2 Application of Entrepreneurial ecosystem approach in developing economies

The current literature on entrepreneurial ecosystem is mostly based on investigation in the regions and cities in advanced economies[3]. Silicon Valley, Boston, Boulder county, and Edinburgh are some of the examples of typical reference cases mentioned in the studies of both empirical and theoretical character. Even the studies comparing various ecosystems from different countries have focused on regions and countries in the developed part of the world (Napier and Hansen, 2011; Audretsch and Belitski, 2016). This could be a reflection of policy-oriented research that naturally stems from the need and the capacity of developed economies. It could also be due to lack of available empirical data for analysis, especially with regards to macro-level quantitative investigation. Regardless of the possible causes for the current lack of attention and application of this approach in the context of developing economies, we acknowledge the need to explore

[3] A couple of studies applied the ecosystem approach in the context of Latin America (Kantis and Federico, 2012) and Kenya (Bramann, 2017).

applicability and relevance of the approach for emerging economies in advancing our understanding of this relatively new approach.

As it was pointed out by Acs et al. (2008), countries have different dynamics of entrepreneurship depending on institutional context and level of economic development. For example, the rate of new firm creation and the ratio of necessity entrepreneurship and opportunity entrepreneurship vary in different national contexts. Some developing economies have a higher level of new firm creation than developed economies, but with a significantly higher share of necessity-driven entrepreneurship due to limited employment opportunities in the labor market (Acs et al., 2008). This signals that there will be different contextual background for the entrepreneurial ecosystem depending on the level of economic development. The most immediate influence of the level of economic development on entrepreneurial ecosystem originates from resource scarcity, which make it hard to create the optimal environments for new business creation (Bramann, 2017). The typical challenges of local entrepreneurs in emerging economies suffering from resource scarcity are low level of consumer demand, weak financial markets, low enforcement of formal institution and regulation, general lack of trust in the society, inefficient administrative system, and underdeveloped infrastructure (Webb et al. 2009; Bramann, 2017; de la Chaux and Okune, 2017).

These challenges are present in most of the fundamental elements of the ecosystem models typically discussed in the literature such as finance, institution, market, and government and regulatory system (e.g. Isenberg, 2011; Stam, 2015). Besides the wide scope of the challenges, another concern for emerging economies is that overcoming these challenges will require long-term effort and investment, meaning that the changes and improvements in each element will not happen overnight. Under these circumstances, what the holistic perspective of entrepreneurial ecosystem can provide is to shed light on relative weak and strong elements in each ecosystem and draw implications for leveraging existing resources in order to create best possible environment for entrepreneurship. The critical assessment of initial conditions of the ecosystem, which accounts for the local entrepreneurial dynamics including the development of contextual factors, will be invaluable for policy design and implementation (Kantis and Federico, 2012). Besides the overview of the system, the assessment based on the ecosystem framework will also point to some focal elements of critical importance for certain local context, which can then be investigated in more detail. This could be another strength of the ecosystem approach that specifies main

fundamental elements and pillars and their relations to each other in depicting the overall picture, allowing for analysis of each element or a group of elements in a system.

Application of the entrepreneurial ecosystem approach in developing and emerging economies would also help enhancing the understanding of various configuration of ecosystems and thereby contribute to the further development and theorization of the approach. This is also in line with the realization that application of the ecosystem approach with the aim of fostering favourable environment for entrepreneurship has been characterised with benchmark of few success stories without much consideration of local context. The recent consent in the literature has been that further development of the ecosystem approach should incorporate the heterogeneity of ecosystems and the evolutionary force behind the emergence of the ecosystems in the local context (Zacharakis et al., 2003; Motoyama et al., 2014; Spigel, 2017). Furthermore, Spigel (2017) asserted that not all elements or attributes need to exist in an ecosystem to successfully support entrepreneurial activities, pointing to the example of Boston, which created a thriving ecosystem without strong local market. Along this line, the analysis of entrepreneurial ecosystem in developing economies may contribute to identifying certain critical elements in facilitating entrepreneurship.

3 Empirical context: Technology entrepreneurship in Kenya

Kenya has achieved steady economic growth with an average growth rate of 5.5 % during the period of 2004-2016 and received attention as one of the KINGS countries (Kenya, Ivory Coast, Nigeria, Ghana, and South Africa) leading the current economic growth in African continent (Osiakawn, 2017). What has gained more interest among scholars is the rise of the ICT sector in Kenya in the recent years (Gathigi and Waititu, 2012; Drouillard et al., 2014; Hain & Jurowetzki, 2015). The capital Nairobi witnessed surge of technology entrepreneurship that has also attracted local and international impact, angel and fund investors (Hussey, 2015; de la Chaux and Okune, 2017). Economist (2012) even named it “Silicon Savannah” with the analogy to Silicon Valley.

There has been cautious[4] anticipation that technology entrepreneurship may have potential to lift social and economic burden that the region has been carrying around for decades (Weiss, 2017). A positive prospect could be made on the account that many of the recent technology start-ups deal with social problems such as absence of physical addresses and reliable postal services (Hain and Jurowetzki, 2015), indicating that new ventures are aiming at making social impact. Furthermore, recent technology-based entrepreneurial activities in Nairobi are characterised by being opportunity-driven than necessity-driven. It is observed that many technology ventures have a clear goal of addressing local market needs with newly available technologies and some non-local technology entrepreneurs even moved to Nairobi in order to pursue venture creation based on specific local needs they detected (Park et al., 2016). As entrepreneurship literature emphasizes the particular importance of 'opportunity-driven' entrepreneurship on economic development (e.g. Acs and Varga, 2005), we could also expect the new ventures to create positive economic impact. All in all, these observations speak for the importance of technology entrepreneurship as potential driving force for economic and social development in the region.

There seems to be three main factors that led to the emergence of high-tech entrepreneurship in Nairobi. The first factor is the rapid dissemination of the mobile technologies following the introduction of mobile phone subscriptions, the arrival of smartphone to the country, and the privatization of the telecommunication sector (cf. Zavatta, 2008). In a GSMA report, 31 per cent of people living in Kenya have at least one mobile subscription (Drouillard et al., 2014), while other studies suggest that 60 per cent of Kenyans living on less than $2.50 a day have access to mobile phones. The second factor is the arrival of the submarine Fiber-Optic Cable to Mombasa in 2009, allowing the country to access a reliable internet connection. Finally, the introduction of revolutionary innovations by pioneers of tech start-up based on the growing consumer markets for technology. M-Pesa within mobile banking and the worldwide renowned Ushahidi crowdsourcing platform are a couple of examples of early start-ups that initiated the entrepreneurial scene in Kenya.

Utilizing the entrepreneurial ecosystem approach on qualitative data from case studies and interviews, Bramann (2017) identified several barriers and enablers of entrepreneurship in the

[4] Weiss (2017) noted that, although new ICT technologies may seem to democratize distribution of information, one need to be aware that few players take control over how seemly abundant information is being created and disseminated.

Kenyan context. The first main barrier is lack of qualified human capital. The absence of knowledge-intensive industries and research institution lead to few individuals with management, entrepreneurial, and technological competences. The second barrier is the Kenyan culture that associates entrepreneurship with low prestige. Entrepreneurial career path is not recognized as an attractive employment option compared to more stable corporate jobs. The next obstacle is the financial landscape. Even though there are records of venture capital deals into several Kenyan Start-ups (Hain and Jurowetzki, 2015), these kinds of investments most often take place later in the finance funnel. Early Stage funding, in particular, is hard to find. Start-ups end up seeking for other type of non-marketed finance such as grant funding (Bramann, 2017), which often fails to identify and support competent ventures. Lastly, the quality of market is still low, meaning that limited source of income hampers the implementation of business-to-customer monetization models in introducing new innovation and leads to utilization of social impact models through government, NGOs, and international development agencies. On the other hand, strong support infrastructure is identified as an important enabler of entrepreneurial activities in Kenya. Nairobi hosts multiple support organizations such as hubs, accelerators, and incubators that nurtures entrepreneurial spirit, provides managerial and entrepreneurial training, and, most importantly, builds active community of entrepreneurs.

In similar vein, Marchant (2015) in the analysis of ICT environment in Kenya also pointed out that local actors such as universities and government bodies lack involvement with and connection to the industry, especially entrepreneurs. This is also shown in weak formal networks in terms of partnership among various actors in the ecosystem such as universities, public organizations, multinationals, and entrepreneurs. On the other hand, informal networks mostly formed around incubators are identified to have critical importance to the entrepreneurial scene in Kenya, providing social proximity among entrepreneurs, which is critical for innovation and interactive learning (Boschma, 2005).

4 Method

Based on previous observations and analyses discussed in the previous section, we focus on informal networks around start-ups and support organizations in Nairobi in our empirical analysis as we consider it a critical driving force in the local entrepreneurial ecosystem. We draw

on the methodology of social network analysis (SNA) and use data from the CrunchBase database and social media platform Twitter to construct the social networks.

4.1 Identifying Start-ups and Supporting Organizations

To identify the central actors in the ecosystem, we first extracted data from CrunchBase (CB). CrunchBase (CB) is the open, community-curated database of TechCrunch with profiles of 650,000 companies, investors, and people. It provides information on technology-based ventures with detailed account of activities including investment rounds and technology descriptions. The dataset was constructed by crawling the graph structure of CB, starting with all listed tech start-up companies in Kenya as well as their listed investors. Then, we identitied 33 tech start-ups, which have documented investment rounds in CB. We argue that the ventures that received investment show better prospect in terms of contributing to economic development in the region and see these ventures as central entrepreneurial actors in the ecosystem.

To identify the main supporting organizations, we used the Twitter REST API to extract all the followers and friends of 31 out of the 33 start-ups that possess a Twitter account. We identified 1410 unique Twitter users. However, as it is typically expected from a social media network, the data contains irrelevant stakeholders for the study such as stars (actors, musicians and sportsmen) and politicians. Nevertheless, we also expect the Kenyan start-ups to follow relevant accounts of support organizations on Twitter. Therefore, we decided to filter the nodes according to the total degree centrality and keep actors which have the most overall interest in the ecosystem. The final network graph is hence composed of 193 unique users including the start-ups for a total of 1948 edges.

We then utilized a typology of actors in an entrepreneurial ecosystem suggested by Motoyama et al. (2014) to classify the accounts. We refer to the authors definition of "Entrepreneurship Support Program" as organizations such as accelerators, chambers of commerce, tech-related conferences, and non-profits that support entrepreneurs. We scanned Twitter timelines and official websites of the different actors to identify supporting organizations[5]. Furthermore, we classified the different feeds in terms of geography. The local accounts refer to

[5] Table 2 in the analysis section reports a description of these supporting organizations.

feeds in Kenya, where most are based in Nairobi. Global accounts include both regional (Kenya neighboring countries) and overseas feeds (United States, Europe).

4.2 Social network analysis and Twitter

The structure of Twitter data makes it a natural fit for network analysis. Twitter data produce networks between users based on their public interactions such as replies, mentions, or re-tweets (Conover et al., 2011; Jürgens et al., 2011). In this paper, we focus on the interactions through mentions, where the author of the tweet mentions another or several other accounts. We argue that mention denotes direct interaction between the two users.

In social network analysis, the ties – or edges – may represent different kinds of relationships. According to Borgatti et al. (2009), a big proportion of social network research studies how four basic types of relations – similarities, social relations, interactions, and flows – affect each other. Twitter mentions can represent the notion of interactions, conceptualized as discrete events which can be counted over time and hence provide both direction and weight to the edge. Whereas the Twitter mention itself does not provide a meaningful flow, it may correspond to a past or future off-line interaction between the two actors. For instance, congratulation to other actor's success story through Twitter mention can imply that there already exists a form of 'personal relation'. It could be interpreted that the involved actors may have had collaboration on projects before or participated together in an event organized by a supporting organization.

We use the following metrics to analyse the networks in our data. To get a grasp of the network and its interconnectedness, we utilize the measures of density and community detection. To understand the role of a specific actor (node) in the network, we use two centrality measures: Total degree centrality and Betweenness centrality.

- Network Density: The network density of a graph reveals how close the graph is from being complete. A perfect dense graph is a graph in which the number of edges is equal to the maximum possible number of edges. It therefore reveals a strong interconnectedness between nodes. The density is represented in terms of percentage.
- Community detection: We clustered the actors by applying the Louvain algorithm (cf. Bondel et al., 2008) which aim is to optimise modularity, defined as a value that measures the density of links inside communities compared to links between communities. Through an iterative process, the algorithm builds communities that have higher density of links. In this paper, we

compute the modularity algorithm included in the Gephi software to determine statistical communities.

- Degree centrality: It accounts all the ties a node has, in a directed network. There are three types of degree centrality: 1) In-degree denoting ties directed to a specific node, 2) out-degree denoting ties originating from a specific node, and 3) total degree centrality as the sum of the previous two, including all interactions a node has with the network. In this paper, we consider total degree centrality as we are interested in both actors, those who initiate interaction and those who are subject to interaction.
- Betweenness centrality: It quantifies the number of times a node acts as a bridge along the shortest path between two other nodes. It then denotes the crucial elements in the network that allow a faster flow of information and interaction. It is a relevant measure for identifying the presence of 'hubs'.

4.3 Limitation of Twitter data

Utilization of Twitter data in the analysis comes with certain limitations. Representativeness and accuracy of the data are main issues as the dataset extracted from social media represents a very specific subset of people of interest (Mislove et al., 2011; Boyd and Crawford, 2012). For instance, a Twitter account may be managed by multiple users and vice-versa, a single person may have several accounts (Boyd and Crawford, 2012). Another issue could be that the data might exclude users who are active 'listeners', meaning that they are part of the network, but do not actively post information on the network (Crawford, 2009; Twitter Blog, 2016). In other words, Twitter users represent a small proportion of internet users and within those users, the usage of Twitter varies from account to account. There is therefore a disparity between accounts in terms of issued tweets (mentions). Furthermore, the data on Twitter represents a static state of the online activity. Therefore, the data gathered for this analysis cannot be used to study the evolution of the ecosystem. It only illustrates the current state based on recent past or close future interaction.

Notwithstanding, Twitter popularity among entrepreneurs has increased in the past few years as a necessary tool to communicate activities and successes as well as convey news on the on-going activities of the ecosystem. It is, nowadays, in the interest of start-ups and support

organizations to develop their activity online to increase their visibility and follow success stories and news on the ecosystem. Even with its shortcomings, Twitter data has clear strength as it is naturally fitted for conducting social network analysis, which, we argue, complements previous studies by highlighting connections of specific set actors of the ecosystem. Finally, the analysis of informal ties is deemed relevant for the specific case of Kenya, where most connections within the ecosystem are perceived to be of informal nature (Merchant, 2015).

5 Empirical analysis

Based on the latest 3200 tweets of each start-up and supporting organization account[6], we extracted available mentions from tweets and built three directed and weighted networks; one network among start-ups, one network among support organizations, and the last network with both start-ups and supporting organizations. In this section, the start-ups and support organizations in the data will be presented along with their respective networks. Then we analyse the network with the interactions of the two type of actors.

5.1 Network of start-ups

Having CrunchBase as our data source, the start-ups in our sample are all technology-based firms. Most companies in our sample work with ICT-related technologies such as mobile communication, mobile payments, apps, and online services, with few exceptions of firms involved with green technologies (see Table 1). While companies pursue different types of business models (for-profit, social businesses, and mixed), a common feature of these companies is that the provided products and services rely on modern technology to overcome inefficiencies in basic infrastructure. The mobile phone became a universal platform for developing and delivering services in areas as different as public transportation and agriculture pricing. Over a third of the companies are developing software, mostly mobile apps, and another roughly 20% rely on Internet platforms, which today are not much different from the former. Other than ICT-related business

[6] The tweets were fetched in January 2017, and 3200 is the maximum number of tweets made available by Twitter.

firms, several companies work with clean-tech and renewable energy technology, addressing the need to provide access to basic sanitation and sustainable electricity for general public.

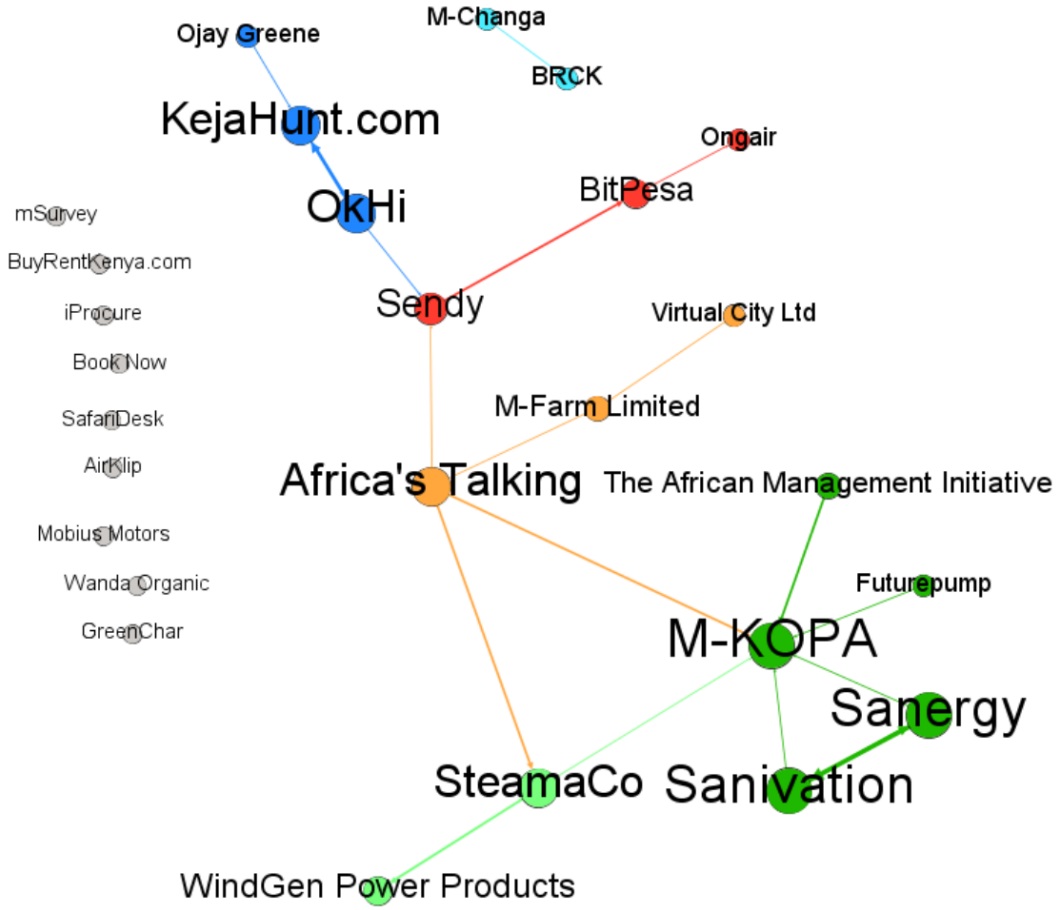
The network below (see Figure 1) illustrates the interactions among the start-ups through mentions and the communities of start-ups identified with the Louvain method. The identified communities are presented in different colors in the network. Green nodes and edges in two different shades represents firms involved with green/energy technologies. The rest of firms based on ICT technologies are divided into smaller groups, represented in blue, red, and orange colors. The two green communities cluster together with higher density of connections compared to the ICT cluster which is divided in small communities with low density of interaction. Certain accounts act as intermediaries in the network (e.g. Africa's talking, Sendy and OkHi). As the color of the edge matches the color of the source node, we can see which communities have a higher tendency to mention others. Africa's Talking tends to mention others and thus is the actor connecting the two sides of the network.

Some central actors are crusial to the network. These popular feeds demonstrate that certain businesses might serve as "role models", exerting a higher impact on the ecosystem. In this network, the popular accounts seem to be: M-Kopa, M-Farm Limited, Sendy and Africa's Talking. It is worth mentioning that, in general, the network lacks interconnectedness among the actors, with many isolated nodes on the left side of the graph. Furthermore, overall low density shows that start-ups do not interact fully among each other, especially in the ICT communities.

Start-up	Founding Date	Desctiption	Sector I*	Sector II*
Virtual City Ltd	2002	Innovative mobility and distribution solutions along the Supply Chain for distributors and retailers of Fast Moving Consumer Goods in emerging markets.	Transportation	Retail
Sanivation	2006	Delivering household sanitation services to peri-urban communities and refugee camps in Kenya.	Clean Technology	Health Services
Mobius Motors	2010	Building low-cost vehicles suited to local demand.	Manufacturing	Transportation
SteamaCo	2010	Enabling convenient buying and selling of off-grid utilities.	Renewable energy	App / Computer Software
Africa's Talking	2010	Mobile phone Software infrastructure integrator across mobile providers in Africa.	Telecommunication	Internet
Sanergy	2010	Sustainable small-scale hygienic sanitation and waste recycling affordable and accessible in urban slums for everyone.	Clean Technology	Health Services
Futurepump	2011	Low-cost, low-maintenance solar powered irrigation pump.	Agribusiness	Renewable Energy
M-Farm Limited	2011	Connect Farmers and Farm Produce Consumers and Give Price Information of Kenyan Markets.	Agribusiness	App / Computer Software
M-KOPA	2011	Solar energy company selling home solar systems.	Renewable energy	App / Computer Software
WindGen Power Products	2011	Small wind turbines for the East-African off-grid energy market	Renewable energy	Clean Technology
The African Management Initiative	2011	Social enterprise offering online and offline learning tools and development initiatives for managers, entrepreneurs and professionals.	Education	Internet
Book Now	2011	Bus travel market place for people in East Africa allowing to book buses.	App / Computer Softwar	Transportation
Umati Capital	2012	Innovative financial services to SMEs and their suppliers particularly in the agro-sector.	Financial Services	Agribusiness
mSurvey	2012	Mobile survey company connecting people, businesses, and organizations through mobile survey conversations.	App / Computer Softwar	Internet
BuyRentKenya.com	2012	Main website portal for the property market in Kenya.	Internet	Real Estate
SafariDesk	2012	travel technology platform giving users personalized travel information from leading travel providers.	App / Computer Softwar	Leisure
GreenChar	2013	Clean household energy social enterprise producing charcoal briquettes and clean cookstoves.	Clean Technology	Renewable Energy
BitPesa	2013	Payment platform connecting digital currencies with mobile payment systems.	Financial Services	Internet
Lipisha	2013	Micro- and Mobile-payment processing for businesses.	Financial Services	App / Computer Software
M-Changa	2013	Mobile phone based fund-raising management service	App / Computer Softwar	Financial Services
BRCK	2013	Rugged, self-powered, mobile WiFi device which connects people and things to the interner in areas of the world with poor infrastructure	Computer Hatdware	Internet
eleni	2013	Building markets in Africa and providing capital, technology solutions and managing services to transform lives.	Agribusiness	Financial Services
iProcure	2013	Optimizing the agriculture input supply chain in rural Kenya	Agribusiness	Professional / Diversified Services
KejaHunt.com	2014	Online house hunting platform that helps find houses without the hustle of agents.	Internet	Real Estate
OkHi	2014	Building the next generation address system in Kenya to overcome the lack of addressing infrastructure	Internet	App / Computer Software
Wanda Organic	2014	Social enterprise set up specifically to focus on soil health in Africa by producing and distributing Bio fertilizer.	Agribusiness	Professional / Diversified Services
Sendy	2014	On-demand door-to-door last mile package delivery services.	Transportation	App / Computer Software
Continental Renewable Energy	2014	Manufacturing eco friendly plastic fencing posts from recycled plastics.	Clean Technology	Construction
Ojay Greene	2014	Working to up-scale smallholder farmers and linking them to profitable urban markets.	Agribusiness	Professional / Diversified Services
AirKlip	2015	Interactive study management app providing collaborative environment for students and administrators.	App / Computer Softwar	Education
Ongair	2015	Customer support through Whatsapp and other instant messaging services for Business.	Internet	Professional / Diversified Services

Table 1 Kenyan Startups. **Information extracted from Park et al. (2016)*

Figure 1 Direct ties (Mentions) between Startups. Colors represent statistical communities computed with the Louvain method.



Legend				
Metrics on the whole network				
Density	3%		Average path	2.08
Community detection and metrics				
Community	Sectors	Density 1	Density 2*	Key Players
●	Internet; App/Software; Services	50%		OkHi
●	Internet; App/Software	33.30%	12.50%	Africa's Talking
●	Internet; App/Software; Services	33.30%		Sendy
●	Clean Tech/Health; Internet/App; Education; Renewable Energy	30%	21.40%	Mkopa Solar
●	Renewable Energy	100%		SteamaCo
●	App/Computer Software and hardware; Internet	100%	100%	*NA*

*Communities are grouped into two main clusters which will serve as reference to compare the results of the different networks.

5.2 Network of support organizations

After filtering the Twitter network connected to the start-ups in our sample, we identified 25 support organizations, 12 organizations based in Kenya (local) and 13 organizations based outside Kenya (global). While local support organizations have been established after 2010, with the exception of Growth Africa, most global support organizations have been established before 2010 with the first ones being founded in the end of the 80s and beginning of 90s (see Table 2). These older global supporting organizations have had strong focus on social innovation and impact entrepreneurship to foster development. The first global supporting organization focusing on for-profit practices (VC4Africa) was established in 2008. Local supporting organizations are mostly innovation hubs, co-working spaces, incubators and accelerators in the realm of high-tech IT entrepreneurship. The connections among supporting organizations are stronger and denser compared to the connections among the start-ups as seen previously (see figure 2). The difference lies as well in the fact that supporting organizations mention each other without clear 'gatekeepers'. The network still depicts more central organizations such as iHub, KenyaCIC, Growth Africa[7] and VillageCapital although it appears to be less centralized.

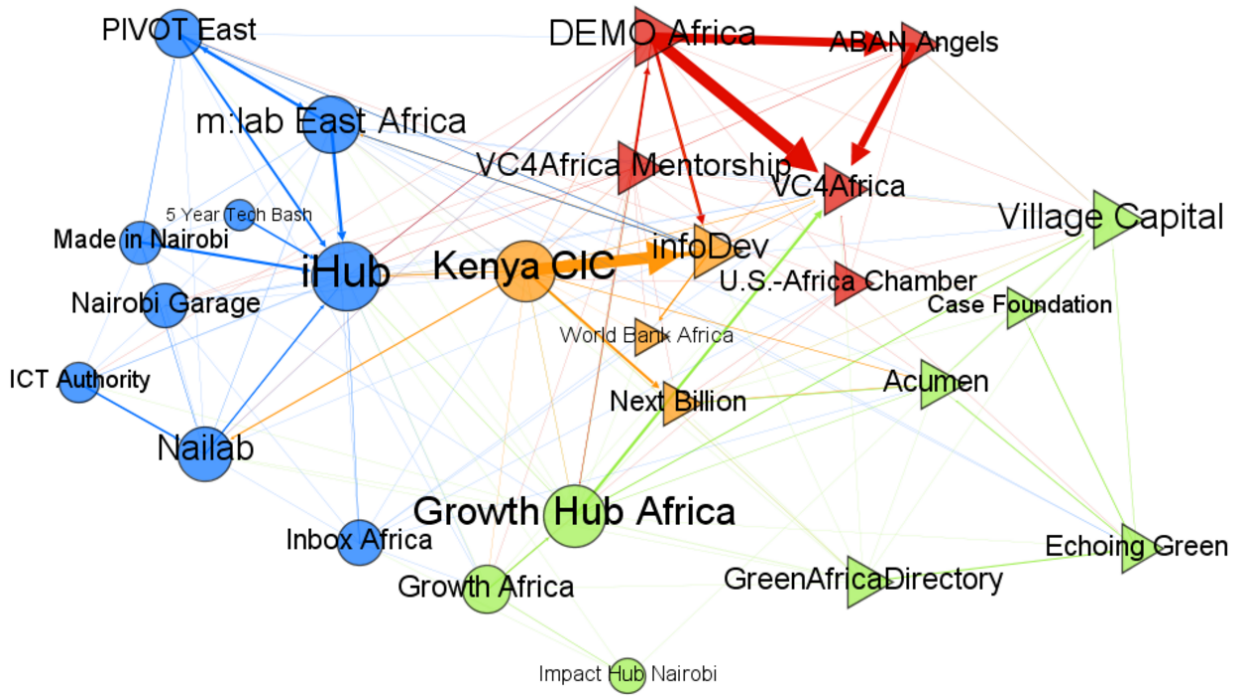
In this network, we identified 4 communities, which differ in terms of their geographic position and focus area/objective. The blue community, for instance, takes the most recognized supporting organizations based in Kenya such as iHub, the first tech hub, m:lab East Africa, the Nailab, Nairobi Garage, and Inbox Africa. The community also comprises Pivot East, the entrepreneurial competition program designed by m:lab East Africa. Note that the blue community is purely local. On the other hand, the red community is composed solely of global actors with a focus on promoting venture capital and angel investment into the African continent. Some other members in this group are the United States African chamber of Commerce as well as DemoAfrica – a pitch conference where promising African Start-ups can interact with and attract investors as well as develop their international visibility.

[7] Growth Hub Africa (deprecated) and Growth Africa are different accounts for the same organization, as of November 2016, Growth Hub Africa was still available and thus we kept the account for reasons of transparency. We reduced the mentions between the accounts to lower self-loops.

Supporting Organization	Founding Date	Desctiption	Geography
Echoing Green	1987	Global nonprofit organization that provides fellowships, seed-stage funding, and strategic support to social entrepreneurs globally.	global
infoDev	1995	A program of the World Bank supporting entrepreneurs in developing countries through research and innovation hubs for climate tech, agribusiness and digital.	global
Case Foundation	1997	Diverse and dynamic institution that creates programs and invest in people and organizations that harness the best impulses of entrepreneurship, innovation, technology and collaboration to drive exponential impact.	global
Acumen	2001	Non-profit global venture fund that uses entrepreneurial approaches to solve the problems of poverty.	global
NextBillion	2005	NextBillion is a community of business leaders, social entrepreneurs, NGO managers, policy makers, academics and others exploring the connection between development and enterprise through analysis, news, jobs and events.	global
VC4Africa	2008	Platform for start-up funding. Fast growing community of business professionals dedicated to building game changing companies on the African continent.	global
Village Capital	2009	Non-profit organization that finds, trains, and funds early-stage ventures solving major global problems in agriculture, education, energy, financial inclusion, and health.	global
World Bank Africa	2010	International financial institution that provides loans to developing countries for capital programs focusing on the African region.	global
VC4Africa Mentorship	2012	VC4Africa exists to support entrepreneurs. We know that starting a business is hard & having access to the right network, knowledge & expertise is essential.	global
GreenAfricaDirectory	2012	Online pan-African network that aims to connect and promote sustainability organisations across Africa and is a green hub for news and	global
DEMO Africa	2012	Flagship initiative of LIONS@frica that aims to connect African startups to the global ecosystem.	global
ABAN Angels	2014	African Business Angels Network (ABAN) is a pan African non-profit association founded to support the development of early stage investor networks across the continent.	global
U.S.-Africa Chamber	2015	Platform of African professionals living in the United States of America and promoting growth for SMEs and non-profits in the U.S.-Africa business nexus through networking, advocacy, and tailored services.	global
GrowthAfrica	2002	Accelerator for African entrepreneurs and impact enterprises providing advisory support, network and access to impact investment.	local
Nailab	2010	Business incubator focused on providing the right ingredients to turn business ideas into viable startups.	local
iHub	2010	Nairobi's Innovation Hub for the technology community is an open space for the technologists, investors, tech companies and hackers in the	local
PIVOT East	2011	PIVOT East is East Africa’s premier mobile startups pitching competition and conference showcasing region's 25 top startups!	local
m:lab East Africa	2011	Identifying, nurturing, and helping to build sustainable East African enterprises with a mobile technology focus.	local
Kenya CIC	2012	Providing incubation, business advisory and financing services to Kenyan entrepreneurs developing innovative solutions that address	local
NairobiGarage	2013	Nairobi's largest co-working tech space.	local
ICT Authority	2013	State Corporation under the Ministry of Information Communication and Technology enforcing ICT standards in Government and enhancing the supervision of its electronic communication.	local
Made in Nairobi	2015	Brings a comprehensive listing of companies established and operated from Nairobi.	local
Inbox Africa	2015	Business Advisory and Consultancy firm that works with SMEs in emerging markets.	local
5 Year Tech Bash	2015	5 year anniversary of iHub.	local
Impact Hub Nairobi	2016	Innovation lab, incubator and social enterprise community centre. An ecosystem of resources, inspiration, and collaboration opportunities.	local

Table 2 Local and Global Supporting Organizations.

Figure 2 Supporting Organizations Network. Colors denote statistical communities using the Louvain method.



Legend				
Metrics on the whole network				
Density	26.30%		Average path	2.186
Community detection and metrics				
Community	Activity	Density 1	Density 2*	Key Players
	Investment; entrepreneurship networking; connection	50%	33%	Demo Africa
	incubator; accelerator; co-working spaces	45.80%		iHub; Nailab;m:lab East Africa
	Development Goals	50%	35.60%	Kenya CIC / infoDev
	Social- innovation,entrepreneurship; impact investment	46.40%		Eccoing Green; Green Africa Directory; Growth Africa

*Communities are grouped into two main clusters which will serve as reference to compare the results of the different networks.

The green cluster is composed by supporting organizations which tend to support social entrepreneurship and development through network facilitation, promoting sustainable social innovations in general. They provide impact investment in the form of seed funding as well as mentoring. The orange cluster is focused on the World Bank initiatives of addressing development issues in Africa. InfoDev, the program established by the World Bank together with Kenya Climate Innovation Center (CIC), target entrepreneurs with initiatives to address climate issues and

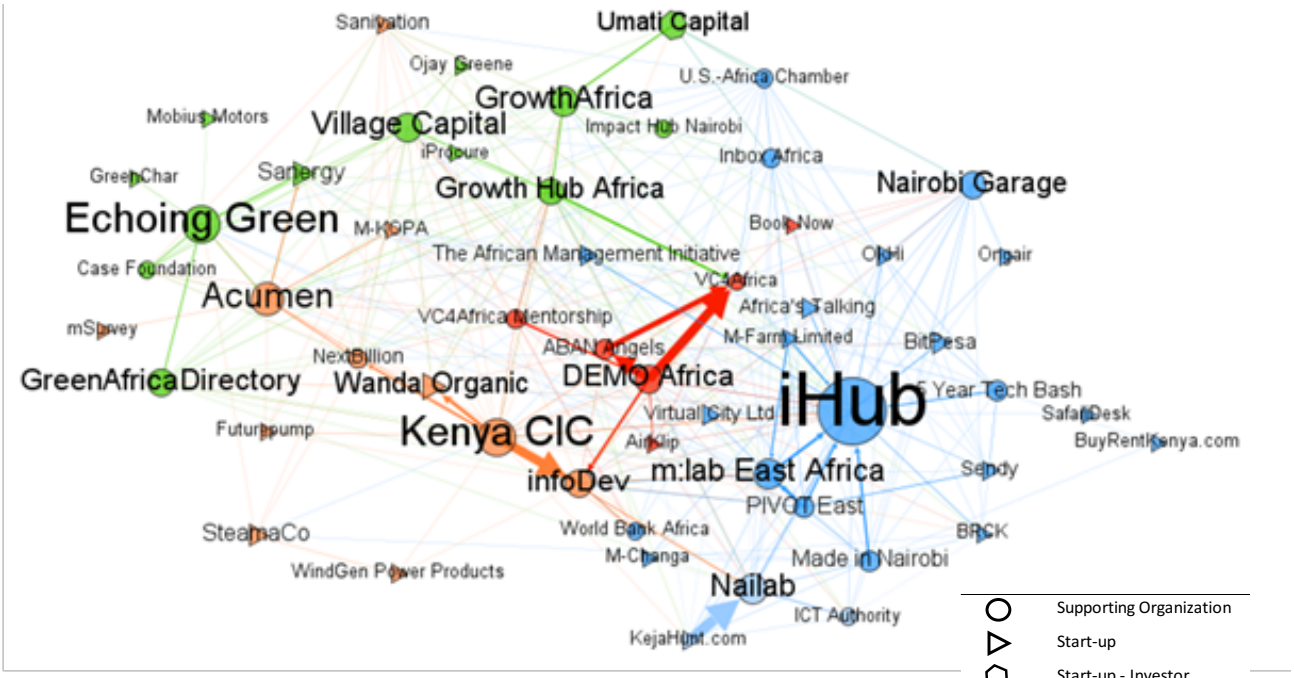
improve the agribusiness sector. Next Billion, similarly, focused on spurring development through entrepreneurial activities at the Base of the pyramid (BoP).

5.3 Network of start-ups and support organizations

After analysing the two types of actors separately, this section merges both networks in an attempt to depict the structure and dynamics of interactions among the two types of actors in the ecosystem. This network shows that support organizations fulfil their role of connecting start-ups (see figure 3). Every isolated start-up in the previous network is now connected to the whole network through one of the supporting organizations. The national supporting organizations cluster around iHub, m:lab East Africa and Nairobi Garage interact mostly with ICT tech start-ups (Two blue communities). The orange community with support organizations targeting agribusiness- and climate-related entrepreneurial activities have interactions with start-ups such as SteamaCo, Wind Generation Power Products, Futurepump, Sanivation and MKopa Solar, which operate in the realm of clean-tech, sustainable energy and agribusiness. The green cluster with global actors supporting social innovation and sustainable entrepreneurial initiatives for development encompasses start-ups such as GreenChar, OjayGreene, Sanergy, iProcure, Mobius Motors and Umati Capital. These companies specialize as well around the agribusiness sector and clean-tech, similar to the orange community. Finally, the red community promoting VC investment includes application based start-ups like Airklip and Book Now Kenya.

While statistical analysis identified five communities described above, we noticed that these five communities can be grouped into two bigger communities based on the interaction pattern and the technology focus. Further investigation on qualitative features of the interaction suggests that there exist one community with ICT firms connected mostly to local support organizations (blue and red) and the other community with green-, agri-, and clean-tech firms connected to global support organizations with dedicated goals of promoting social innovation (green and orange). Table 3 shows how network measures differ between the two big communities which will be called social innovation community and ICT community in the rest of the article.

Figure 3 Direct interactions (mentions) between start-ups and supporting organizations. Colors denote statistical communities detected by the Louvain algorithm.



Legend					
Metrics on the whole network					
Density	13.90%		Average path	2.38	
Community detection and metrics					
Community	Activity	Sector	Density 1	Density 2*	Key Players
	Investment	App based	40%		Demo Africa
	Technology; Networking; Incubator/Accelerator/Co-working space	App/Computer Software and hardware; internet; Services	21.90%	20.50%	iHub/Nairobi Garage/m:lab East Africa; Sendy/OkHi/Virtual City
	Promoting Technology and entrepreneurship	internet	100%		Nailab
	Development Goals; Social entrepreneurship	Agribusiness; Clean	27.30%		Acument; Wanda Organic
	Social Innovation; Impact investment	Renewable energy; Agribusiness; Clean Technology; Low-cost mobility	23.10%	15.50%	Eccoing Green; Sanergy

*Communities are grouped into two main clusters which will serve as reference to compare the results of the different networks.

Table 3 Identification of two major communities in the Network along with Density metrics.

	Social vs ICT community	
	Social Innovation Community	ICT community
Communities (from Figure 3)		
Density among Start-ups	21.40%	12.50%
Density among Supporting organisations	35.60%	33%
Density between all actors	20.50%	15.50%
Key Players	Eccoing Green; Kenya CIC; Wanda Organic; Acumen	iHub; Nailab; m:lab East Africa; Virtual City; Sendy; OkHi

The network of social innovation community shows there is relatively uniform level of interaction at both the start-up and the supporting organization level. This can be noticed by the size of the node in the green and orange networks, which illustrates betweenness centrality. In the start-up part of the network, the agribusiness/clean-tech firms appear to be very well connected around MKopa Solar. The support organizations also are well connected to each other with equal presence. Another noticeable character of the interaction of this community is that the start-ups tend to have higher interaction with global stakeholders. This gives us an overall picture that, on the one side, entrepreneurs have active interaction among themselves at the local level (relatively higher density in the start-up mentions network), but, on the other hand, their supporters operate at a global sphere and these start-ups might lack 'local' interaction with physical proximity.

The network of ICT community shows a different interaction pattern. ICT start-ups are mostly clustered around local hub such as iHub, m:lab East Africa and Nairobi Garage, which has a significantly high centrality in the network. Rather than having direct connection among themselves, firms are connected to each other through these hubs. Although the local support organizations contribute with knowledge creation and sharing through interaction within the co-working space iHub and other events or programs created by m:lab and Nairobi Garage, the presence of such a centralized structure may undermine the resilience of the community.

Each community also has different historical backgrounds behind their development. Social innovation community's connection to global development-oriented organization originates from the old model of pursuing development goals based on external aid from Non-Governmental Organizations (NGOs) that have existed in the country for several decades. On the other hand, the emergence of ICT start-ups and local hubs is closely related to the arrival of the submarine fiber cable, which provided solid infrastructural foundation for application of new technologies in the local market.

Although the two communities show different internal relational dynamics and are distinguished for the difference, some actors are still connected across the communities (mostly through support organizations), signaling that there exists a certain level of interaction between the communities. The characteristics of the two communities are summarised in table 4.

Table 4 Characteristics of the two communities detected in the networks

	ICT Tech Community	Social Tech Community
Industry and technology orientation	Internet, App and Software Development	Renewable Energy, Clean Technology and Agribusiness
Interaction	Interaction around a Supporting Organization	Interaction between members and supporting organizations
Geographical Orientation	Interactions with local actors mainly	Interaction with international supporting organizations
Historical background	Start-up enabled with the arrival of fiber cable internet in Kenya in late 2000's.	Aim at addressing Development Goals following the high implication of NGO's in the country.
Business model	Profit Oriented. Still addressing Social problems via technology.	Social oriented. Mostly For-Profit Social enterprises

6 Discussion

Nairobi's entrepreneurial environment shows clear deficiency in major domains of the ecosystem such as human capital, governmental leadership, regulation, financial markets, and university and research institutions as it is typically the case in many emerging economies (Bramann, 2017; de la Chaux and Okune, 2017). We posit that, by utilizing entrepreneurial ecosystem approach, developing economies are able to identify relatively strong elements in the system that they can leverage to overcome other weaknesses in the system. We, therefore, direct our attention to the strongest element in the system, namely, the relations between start-ups and support system, and analyse the ecosystem based on these connections. Although we focus on certain elements of the ecosystem in our empirical analysis, we aim to shed light on how these specific elements can be used to strengthen the current entrepreneurial ecosystem as a whole in Nairobi.

Through the analysis of the Twitter mention networks of technology start-ups and support organizations, we identified two distinctive communities of actors based on entrepreneurial dynamics. As presented in the previous section, the two communities differ in the following areas: interaction pattern among entrepreneurs and support organizations, geographical scope of interaction, technology orientation, profit orientation of start-ups, and historical background. Some of the differences will be discussed in detail with the implications for the literature and policy making.

To begin with, the existence of two distinctive communities based in the same locality raises the issue of how one defines an 'entrepreneurial ecosystem' with geographic and relational scope. If we place more emphasis on the impact of interaction pattern and technological focus on entrepreneurial processes and outcome, we could also argue that there exist two different ecosystems in Nairobi. One could contend that the feedback and reinforcement among various elements of the system (Spigel, 2017) could eventually lead to emergence of two distinctive ecosystems. For example, the different interaction patterns may lead to development of different entrepreneurial culture within the two communities and the entrepreneurs can be influenced by different norms and behavioural expectation in each community. Moreover, different technology fields associated with each community means that they are likely to face different market needs with various levels of consumer expectation and price sensitivity, which has rather direct influence on entrepreneurial outcome. The type of support organization involved in each community also suggest that there may be different funding and financing possibilities for the two communities. Since the social community has close connection to development-oriented global support organizations with clear social goals (such as KenyaCIC and Echoing Green), there could be easier access to financial resources with development aid character. However, this may not necessarily lead to 'productive entrepreneurship' (Stam, 2015), as funding of this nature does not have efficient mechanisms for supporting ventures with high potential (Bramann, 2017).

Defining 'entrepreneurial ecosystem' in practice also has geographical aspect to consider. The current conceptualization of entrepreneurial ecosystem does not provide clear indication on which geographical level the ecosystem can best be defined and utilized (Mason and Brown, 2014; Stam, 2015). The general discussion is characterised with orientation towards the regional (sub-national) aspects as it typically is compared to clusters and regional innovation systems (Spigel, 2017), but the current application of the concept does not confine to specific geographical scale or

size of the involved territories (Napier and Hansen, 2011). The consensus seems to be that, no matter which level they are defined at, the 'local' contextual factors that influence entrepreneurial endeavours matter. In our empirical case, the starting point of geographical demarcation of the ecosystem is Nairobi as a city. However, based on the discussion above, one may identify two different ecosystems in one city or region.

Another important geographical aspect to mention in relation to Nairobi's ecosystem is that one of the communities has strong connection to global support organizations. Although our analysis is based on the networks of local start-ups based in Nairobi, the geographical scope of critical interaction of these start-ups spans beyond the local context of Nairobi. As it is the case in Nairobi, when the network and interaction between the start-up and support organization constitutes a significant share of the entrepreneurial dynamics, this could raise the question of how 'locally-oriented' certain ecosystems are. What can then advocate for the 'localness' of entrepreneurial ecosystem is that the start-ups are still under the conditions such as physical infrastructure, formal institutions, policies and culture with strong regional and national foundation.

The relational construct between various elements in the system as suggested by Spigel (2017) points to the possibility of nurturing relatively weak elements through the function of strong elements as well. Based on the strong connection and interaction among 'social purpose' technology start-ups, one could start building more positive view on entrepreneurship in general in the society by highlighting the social impact of these ventures. With high level of embeddedness of support organizations in start-up networks, one can also expect these organizations to take over the roles of other actors in the system such as universities and investors. Support organizations can expand their activities to training/education and investment to compensate for the lack of support to these areas in the system. With regards to this, connection to global actors can be critical as this can function as 'global pipelines' to source advanced knowledge and financial resources from abroad (Maskell et al., 2005).

Another interesting finding that characterises the entrepreneurial scene in Nairobi is that there is a unique combination of for-profit business models and social impact models. We observe a number of successful start-ups introducing high societal impact ICT innovations (e.g. M-Pesa and Usahidi). Indeed, the pursuit of social impact has been the ecosystem's "code of conduct" for a long time through the presence of many international NGOs promoting the necessity to achieve

development goals and solve societal issues. While some international solutions imported into the country in the hope that they will solve local social issues had failed to achieve the expected outcome in the past, there is now expectation that locally developed solutions will emerge to address the different issues of the country (Lewis, 2014).

In the analysis of the networks, we noted several supporting organizations that aim at tackling certain critical societal issues such as climate change and clean energy — e.g. InfoDev, Kenya CIC —, a group of technology start-ups with a clear social purpose — Sanivation, Futurepump, M-Changa, Sanergy, Ushaidi, African Management Initiative —, and other start-ups that could be considered as social-driven with less pronounced emphasis — GreenChar, M-Kopa, SteamaCo and Wanda Organic. Even the start-ups with clear for-profit business models, intendedly or not, address social issues as the market and customer needs in developing economies often originate from the lack of basic infrastructure and public services. As an example, BRCK, which is clearly pursuing for-profit business model, offers solutions to deal with unfavourable electricity infrastructure in Kenya. This speaks for the importance of strengthening entrepreneurial ecosystem in Nairobi, which can serve as fertile ground for nurturing ventures driving both social and economic development. Social and economic development will be the concrete outcome of aggregate value creation in an entrepreneurial ecosystem model, which can be seen as the final goal of the ecosystem as conceptualised by Stam (2015).

The co-existence of for-profit and social purpose start-ups in Nairobi is a unique feature of the ecosystem that requires more attention. Social innovation communities in other parts of the world tend to develop strong community spirit that marks clear distinction from typical for-profit businesses. Accordingly, there is no active interaction among for-profit businesses and social enterprises. However, in Nairobi, we observe some connection and interaction between actors in the community of for-profit start-ups and the community of social purpose start-ups. They are mostly connected to each other through support organizations, which may signal that they participate in the same support programs or events organised by the support organizations. This setting provides opportunities for developing unique business models combining approaches from the two communities, but this may require more dedicated facilitation through concrete initiatives.

Lastly, it seems as though the lack of strong government leadership in facilitating the ecosystem is compensated by bottom-up forces driven by individual entrepreneurs and the communities around the support organizations. Without clear direction with policy initiatives,

entrepreneurial activities were initiated by highly motivated individuals and yielded outcome as can be witnessed with the emergence of technology ventures. Certain key individuals and support organizations (e.g. iHub) worked as catalysts in creating an active community of IT based ventures, following the installation and dissemination of mobile and internet technologies. The other community in the ecosystem has gained force in the local context based on long-term presence of development agencies. This shows that there exist historical events and background behind the evolution of ecosystem in Nairobi, which is important to account for in understanding the current construct of the ecosystem.

7 Conclusion

In this paper, we analysed Twitter network of technology start-ups and support organizations in Nairobi in an attempt to sketch out the interaction between the two central actors in the local entrepreneurial ecosystem. The network analysis led to identification of two main communities in a local ecosystem, social innovation community and ICT community, based on various qualitative features such as technological focus, business models, and interaction pattern among the actors. The local technology start-ups are connected to different types of support organizations depending on the technology profile and the business model, which further leads to different geographical span in their interaction.

The social innovation community ventures aim to solve social issues within agriculture, energy and general infrastructure based on new technologies. These start-ups have active direct connection among themselves and are mostly connected to global support organizations with specific development goals. On the other hand, ICT community has stronger profit orientation with businesses based on new ICT technologies such as apps and other mobile and online platforms. Without active direct interaction among themselves, these ventures are connected in the network through few local hubs such as co-working spaces, incubator and accelerators.

Our findings have the following main implications in enhancing the understanding of entrepreneurial ecosystems. Firstly, we find that there may be issues regarding the level of analysis both in terms of the interaction of the involved actors and geographical scale when utilizing the ecosystem approach. In Nairobi, we observe two different entrepreneurial dynamics with distinctive characters based on interaction patterns of main actors. If we assume that the relations

between ventures and support organizations constitute a critical focal point of the ecosystem as it can be the case in many developing economies with weak institutions, we may also need to consider them as different ecosystems co-existing in the same locality and support them in different ways. Regarding the geographical scale, we show that some ecosystems around local start-ups may have strong connection to global actors, which often serve as critical channels for sourcing resources that are not easily accessible in the local context. Without clear definition of the geographical boundary of the concept, this may suggest, on the one hand, the possible extension of the concept across different levels of geographical scale, but on the other hand, it may also indicate difficulties in maintaining consistency in the level of analysis in the literature.

Secondly, we demonstrate that the ecosystem framework is as relevant and useful in the context of developing economies as in developed economies. This is also in line with the advantage of the ecosystem construct that, apart from providing the holistic view, it also allows dissecting the system in elements and directing focus on certain critical elements in studying the ecosystem. We argue that, for emerging economies, focusing on existing and thriving elements in creating productive supporting environment is of great importance, and the ecosystem approach can be used to point out these elements. We showed, furthermore, that the focused analysis on certain elements can be discussed in relation to other elements in the ecosystem, thereby enhancing the understanding of the ecosystem as a whole in the end.

The analysis of the interaction in the ecosystem in Nairobi also points to some policy implications. As mentioned before, interaction with global actors could function as mechanism for sourcing relevant resources and increasing local knowledge and competences related to entrepreneurial activities. Actively supporting these relations would induce productive entrepreneurial outcome in a relatively short-time span, compared to the effort and investments to strengthen other elements in the ecosystem such as informal institution, education and market, which typically requires longer time to establish. In addition, the unique setting of co-existence of for-profit and social enterprises could be more actively utilized in facilitating innovative solutions for social and economic challenges that Kenya faces. Encouraging more interaction between the two communities with different business models can inspire entrepreneurs and support organizations from the both sides, which could lead to creative innovation. As this construct is rarely found in developed economies, it would also be a great opportunity to create a successful model that originates from a developing economy and benchmarked in the rest of the world.

The use of social network analysis is compatible with the network dimension of the entrepreneurial ecosystem approach. We also argue that the sample extracted from CrunchBase reflects important actors which have potential to scale-up or considerably impact the local development. Twitter mention network utilized in this study provides an approximation to offline informal connections that seem to be important in the context of Kenya. However, we acknowledge that there may be disparity in online activity between two actors and their real-life interaction in the community. Moreover, such a small selection of firms included in the analysis raises issues regarding the representativeness of the sample. It would be, therefore, interesting for further research to expand the twitter sample, to merge twitter data with CrunchBase and qualitatively gather data on the ecosystem. Furthermore, to draw deeper insights on the ecosystem, it is crucial to complement social network analysis with empirical findings from qualitative studies, or combine network metrics with socio-economic datasets to perform quantitative studies on the ecosystem. Other than improving the methodology, further studies could incrementally include other actors (investors, government, education, etc.) in the ecosystem to understand the dynamics of the whole network. Furthermore, relevant social media data extracted regularly may be used to construct dynamic networks and explore the evolutionary aspect of the entrepreneurial ecosystem. Finally, the analysis of the evolution of communities can be compared to historical data on ecosystem events, government policies and programs as well as on global stakeholder's activities (e.g. NGO's projects in the region, etc.) and give intuitions on causality of the ecosystem development.

Bibliography

Acs, Z. J., & Varga, A. (2005). Entrepreneurship, agglomeration and technological change. Small Business Economics, 24(3), 323-334.

Acs, Z. J., Desai, S., & Hessels, J. (2008). Entrepreneurship, economic development and institutions. Small business economics, 31(3), 219-234.

Acs, Z. J., Autio, E. & Szerb, L. (2014) National Systems of Entrepreneurship: Measurement Issues and Policy Implications. Research Policy 43(3): 476–449.

Audretsch, D. B., & Lehmann, E. E. (2005). Does the Knowledge Spillover Theory of Entrepreneurship hold for regions? Research Policy, 34(8), 1191–1202. https://doi.org/http://dx.doi.org/10.1016/j.respol.2005.03.012

Audretsch, D. B., & Belitski, M. (2016). Entrepreneurial ecosystems in cities: establishing the framework conditions. The Journal of Technology Transfer, 1-22.

Blondel, V. D., Guillaume, J. L., Lambiotte, R., & Lefebvre, E. (2008). Fast unfolding of communities in large networks. Journal of statistical mechanics: theory and experiment, 2008(10), P10008.

Boschma, R. (2005). Proximity and innovation: a critical assessment. Regional studies, 39(1), 61-74

Boyd, D., & Crawford, K. (2012). Critical questions for big data: Provocations for a cultural, technological, and scholarly phenomenon. Information, communication & society, 15(5), 662-679.

Bramann, J. U. (2017). Building ICT Entrepreneurship Ecosystems in Resource-Scarce Contexts: Learnings from Kenya's "Silicon Savannah". In Digital Kenya (pp. 227-264). Palgrave Macmillan UK.

Bresnahan, T., Gambardella, A., & Saxenian, A. (2001). 'Old economy'inputs for 'new economy'outcomes: cluster formation in the new Silicon Valleys. Industrial and corporate change, 10(4), 835-860.

Conover, M., Ratkiewicz, J., Francisco, M. R., Gonçalves, B., Menczer, F., & Flammini, A. (2011). Political polarization on twitter. ICWSM, 133, 89-96.

Crawford, K. (2009). Following you: Disciplines of listening in social media. Continuum: Journal of Media & Cultural Studies, 23(4), 525-535.

de la Chaux, M., & Okune, A. (2017). The Challenges of Technology Entrepreneurship in Emerging Markets: A Case Study in Nairobi. In Digital Kenya (pp. 265-301). Palgrave Macmillan UK.

Drouillard, M., Taverner, D., Williamson, C., & Harris, M. (2014). Digital entrepreneurship in Kenya . London: GSMA

Economist. (2012). Upwardly mobile. Th e Economist . http://www.economist. com/node/21560912 . Accessed 14 Dec. 2016

Feld, B. (2012). Startup Communities: building an entrepreneurial ecosystem in your city. Hoboken: John Wiley & Sons.

Freeman, C. (1995). The 'National System of Innovation'in historical perspective. Cambridge Journal of economics, 19(1), 5-24.

Gathigi, G., & Waititu, E. (2012). Coding for Development in the Silicon Savannah: The Emerging Role of Digital Technology in Kenya. Re-imagining Development Communication in Africa, 201.

Hain, D., & Jurowetzki, R. (2015). Silicon Savanna? Local Competence Building and International Venture Capital in Low Income Countries.

Hussey, M. (2015). Silicon Savannah: How start-ups in Africa are taking on some of humanity's biggest challenges. Huffi ngton Post . http://www.huffi ngtonpost.co.uk/matthew-hussey/african-startups-take-on-challenges_b_ 6416676.html . Accessed 19 Feb 2016.

Isenberg, D. J. (2011). The Entrepreneurship Ecosystem Strategy as a New Paradigm for Economic Policy: Principles for Cultivating Entrepreneurship, the Babson Entrepreneurship Ecosystem Project. Babson College, Massachusetts

Jürgens, P., Jungherr, A., & Schoen, H. (2011, June). Small worlds with a difference: New gatekeepers and the filtering of political information on Twitter. In Proceedings of the 3rd International Web Science Conference (p. 21). ACM.

Kantis, H. D., & Federico, J. S. (2012). Entrepreneurial Ecosystems in Latin America: the role of policies. International Research and Policy Roundtable (Kauffman Foundation), Liverpool, UK.

Lee, K. (2013). Schumpeterian Analysis of Economic Catch-up: Knowledge, Path-Creation, and the Middle-Income Trap. Cambridge University Press.

Lewis, D. (2014, April 11). Africa must back entrepreneurs: Omidyar Network. Reuters

Lundvall, B. A. (1992). National innovation system: towards a theory of innovation and interactive learning. Pinter, London.

Malecki, E. J. (2011). Connecting local entrepreneurial ecosystems to global innovation networks: open innovation, double networks and knowledge integration. International Journal of Entrepreneurship and Innovation Management, 14(1), 36-59.

Marchant, E. (2015). Who is ICT Innovation For Challenges to Existing Theories of Innovation, a Kenyan Case Study.

Maskell, P., Bathelt, H., & Malmberg, A. (2006). Building global knowledge pipelines: The role of temporary clusters. European planning studies, 14(8), 997-1013.

Mason, C. & Brown, R. (2014) Entrepreneurial ecosystems and growth oriented entrepreneurship. Background paper prepared for the workshop organised by the OECD LEED Programme and the Dutch Ministry of Economic Affairs on Entrepreneurial Ecosystems and Growth Oriented Entrepreneurship, The Hague, Netherlands

Mislove, A., Lehmann, S., Ahn, Y. Y., Onnela, J. P., & Rosenquist, J. N. (2011). Understanding the Demographics of Twitter Users. ICWSM, 11, 5th.

Motoyama, Y., Konczal, J., Bell-Masterson, J., & Morelix, A. (2014). Think locally, act locally: Building a robust entrepreneurial ecosystem. Act Locally: Building a Robust Entrepreneurial Ecosystem (April 2014).

Motoyama, Y., & Watkins, K. K. (2014). Examining the connections within the startup ecosystem: A case study of st. louis. Louis (September 1, 2014). Kauffman Foundation Research Series on City, Metro, and Regional Entrepreneurship.

Napier, G., & Hansen, C. (2011). Ecosystems for young scalable firms. FORA Group.

Neck, H. M., Meyer, G. D., Cohen, B., & Corbett, A. C. (2004). An entrepreneurial system view of new venture creation. Journal of Small Business Management, 42(2), 190-208.

Osiakwan, E. M. (2017). The KINGS of Africa's Digital Economy. In Digital Kenya (pp. 55-92). Palgrave Macmillan UK.

Schumpeter, J. A. (1934). The theory of economic development: An inquiry into profits, capital, credit, interest, and the business cycle (Vol. 55). Transaction publishers.

Spigel, B. (2017). The Relational Organization of Entrepreneurial Ecosystems. Entrepreneurship Theory and Practice, 41(1), 49–72. https://doi.org/10.1111/etap.12167

Spilling, O. R. (1996). The entrepreneurial system: On entrepreneurship in the context of a mega-event. Journal of Business research, 36(1), 91-103.

Stam, E., Suddle, K., Hessels, J. & Van Stel, A. (2009) High-Growth Entrepreneurs, Public Policies and Economic Growth. In: Leitao, J. & Baptista, R. (eds) Public Policies for Fostering Entrepreneurship: A European Perspective. New York: Springer. pp. 91-110.

Stam, E., Bosma, N., Van Witteloostuijn, A., De Jong, J., Bogaert, S., Edwards, N., & Jaspers, F. (2012). Ambitious entrepreneurship. A review of the academic literature and new directions for public policy, AWT report, 41.

Stam, E. (2014). The Dutch entrepreneurial ecosystem. Available at SSRN 2473475.

Stam, E. (2015). Entrepreneurial ecosystems and regional policy: a sympathetic critique. European Planning Studies, 23(9), 1759-1769.

Stangler, D., & Bell-Masterson, J. (2015). Measuring an entrepreneurial ecosystem. Kansas City.

Twitter Blog. 2016. One hundred million voices. Twitter, Inc. http://bit.ly/2ajdB1n (last accessed 2 December 2016).

Van de Ven, H. (1993). The development of an infrastructure for entrepreneurship. Journal of Business venturing, 8(3), 211-230

Webb, J. W., Tihanyi, L., Ireland, R. D., & Sirmon, D. G. (2009). You say illegal, I say legitimate: Entrepreneurship in the informal economy. Academy of Management Review, 34(3), 492-510.

Ndemo, B., & Weiss, T. (Eds.). (2016). Digital Kenya: An Entrepreneurial Revolution in the Making. Springer.

Wong, P., Ho, Y. & Autio, E. (2005) Entrepreneurship, Innovation and Economic Growth: Evidence from GEM data, Small Business Economics 24(3): 335-350

World Economic Forum (2013) Entrepreneurial Ecosystems around the Globe and Company Growth Dynamics (Davos: World Economic Forum).

Busenitz, L. W., West III, G. P., Shepherd, D., Nelson, T., Chandler, G. N., & Zacharakis, A. (2003). Entrepreneurship research in emergence: Past trends and future directions. Journal of management, 29(3), 285-308.